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A TEST OF THE PHASE PICK-UPS USED IN THE PSB AND A SUGGESTED MODIFICATION

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1. INTRODUCTION

The PSB has 5 phase pick-ups, and the 3 positions we find amplifiers connected to them are 5L1, 14L4 (with unity gain for high intensity beams), and 8L1 (with a gain of 10 for low intensity beams). The details of these pick-ups and amplifiers are outlined in PS/RF/Note 96-15 by G. Schneider.

The tests carried out were to ensure that all installed amplifiers were functioning as expected, with respect to gain bandwidth, phase linearity and current drawn from the power supply.

There are 2 different amplifiers installed, one designed for unity gain which uses an obsolete amplifier, the LH0033, and the other is designed around the AD811 which has been made with a gain of 10. As the unity gain amplifier would need replacement in case of any problems, the AD811 design was to be checked to ensure that it would work also as a unity gain amplifier.

2. TEST SET-UP FOR BANDWITH AND PHASE MEASUREMENTS

The amplifiers were removed from the machine for testing in the lab. A network analyser was used to check the gain and phase characteristics, the set–up of which is shown in fig 1.

The input to the amplifier is the source of the network analyser, one output must be terminated into 50 Ohms, and the other output connected to the test input of the analyser. As both 0 & 180 degree outputs are used, both should be tested.

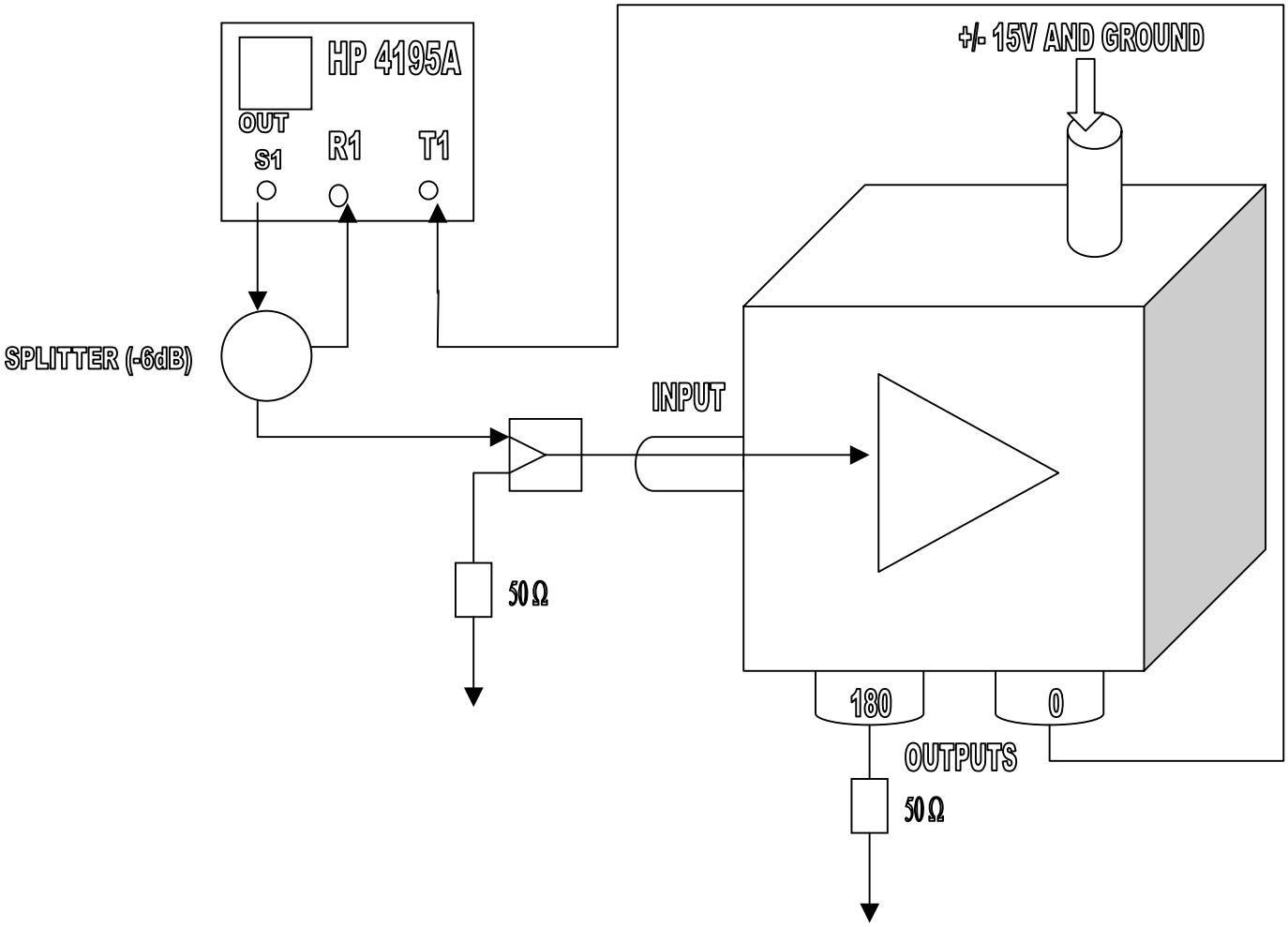

Fig 1

3. RESULTS OF BANDWIDTH AND PHASE MEASUREMENTS

The figures 2 to 25 show the results from each amplifier's zero degree output, first with a linear scale from 0.5-3.5 MHz, then with a logarithmic scale from 0.05-50 MHz.

The plots demonstrate that the G=1 amplifiers have a –3 dB bandwidth of just under 50 MHz, whereas the G=10 amplifiers are closer to 45MHz bandwidth.

4. MAXIMUM INPUT VOLTAGE TEST

The G=1 amplifiers are used for the proton cycles, where a single bunch may contain up to $1*10^{13}$ charges. Study of the phase pick-up design data suggests that for this number of particles with an assumed Cosine distribution, a bunch length of π radians on h=1 (short bunches), then 12 V_{p-p} will be developed on the pick-up. The signal developed for the second RF harmonic will be 0.106 of the h=1 value, or 1.27 V_{p-p}.

In the case where we have flat bunches (hollow distribution or dual harmonic), one can assume a square wave signal with 75% duty cycle. In this case the maximum h=1 component would be 4.6 V_{p-p}, with h=2 approximately 3.2 V_{p-p} and h=3 approximately 1.5 V_{p-p}.

The maximum input voltage applied to the G=1 amplifier before deformation of the output could be observed, was tested as follows. A signal generator was connected via an oscilloscope (1MΩ impedance) to the input, one output was terminated in 50Ω with the other applied to an oscilloscope terminated with 50Ω. The results are shown in Table 1.

Harmonic Number	Maximum V_{p-p} applied to Input	Test Frequency (MHz)	V_{p-p} Output into 50Ω
1	26.3	0.6	5.8
1	26.0	1	5.8
1 AND 2	25.8	1.2	5.8
1 AND 2	25.8	1.5	5.8
1 AND 2	25.8	1.7	5.8
2 AND 3	25.4	2	5.6
2 AND 3	25.0	2.5	5.8
2 AND 3	24.8	3	5.8
2 AND 3	24.6	3.4	5.6
3	24.4	4	5.6
3	24.1	4.5	5.6
3	23.6	5	5.5
3	23.6	5.1	5.5

Table 1

It should be noted that this test showed there is a ripple on the +15V supply, which could be seen to be at the input frequency. This could be observed when the amplitude of the input signal and the frequency were increased above a certain level. This was found to be out with the working range in this application.

5. TEST OF CURRENT DRAWN BY AMPLIFIER WITH G=1

Table 2 demonstrates the current drawn from the power supply for the old design using the LH0033, set up for unity gain, as used for the 5L1 and 14L4 pick-ups. The input is a signal generator with a 2 V_{p-p} sine wave output.

Current drawn	Input Active and 50Ω on each Output	Iput Active, one Output 50Ω, other Open	Input Active, both Outputs Open	No Input, both Outputs Open	No Input, both Outputs 50Ω
From +15V	17.3 mA	17.3 mA	17.3 mA	17.2 mA	17.2 mA
From –15V	17.2 mA	17.2 mA	17.2 mA	17.2 mA	17.2 mA

Table 2

6. TEST OF CURRENT DRAWN BY AMPLIFIER WITH G=10

Table 3 demonstrates the current drawn from the power supply for the new design using the AD811, set up for a gain of 10, as used for the 8L1 pick-ups. The input is a signal generator with a 2 V_{p-p} sine wave output.

Current drawn	Input and 50Ω on each Output	Input, one Output 50Ω, other Open	Input, both Outputs Open	No Input, both Outputs Open	No Input, both Outputs 50Ω
From +15V	30.8 mA	25.5 mA	17.7 mA	17.1 mA	17.1 mA
From –15V	30.7 mA	25.4 mA	17.7 mA	17.1 mA	17.1 mA

Table 3

7. POSSIBLE USE OF G=10 CIRCUIT WITH UNITY GAIN

As the present G=1 circuit uses an obsolete amplifier, a replacement circuit will be required in the near future. It was seen from the design data that the AD811 amplifier circuit may well be capable of being used as a unity gain amplifier with a minimum, if indeed any, of modification.

The circuit diagram for the AD811 can be seen in figure 26, where a relay switches between G=1 and G=10. The present G=10 circuit has this function hard wired to G=10, but this can simply be modified to be hard wired for unity gain. It is not presently necessary to change between the two gains via the control relay, so this will be omitted for the moment.

Figures 27 and 28 show the response of this circuit when tested according to the method used in Section 3. This means that the unity gain AD811 has a greater bandwidth than the LH0033 design, and figure 29 demonstrates this to be in excess of 100 MHz with 9dBm input power. The present design uses a feed back resistor of 750Ω, which gives a 3 dB peak at approximately 70 MHz. If this value is changed to 1.47 kΩ, this peak is reduced as can also be seen in figure 29.

The current that would be drawn by a modified AD811 design is shown in Table 4 to be similar to that of the old design, so the existing power supply need not be changed. The input is a signal generator with a 2 V_{p-p} sine wave output.

Current drawn	Input and 50Ω on each Output	Input, one Output 50Ω, other Open	Input, both Outputs Open	No Input, both Outputs Open	No Input, both Outputs 50Ω
From +15V	16.7 mA	16.6 mA	16.6 mA	16.6 mA	16.6 mA
From –15V	16.7 mA	16.6 mA	16.6 mA	16.6 mA	16.6 mA

Table 4

8. MODIFICATIONS TO EXISTING PCB

The PCB that is presently used for the AD811 needs some modification from the original design produced, so this will be done for the next series of PCB's ordered.